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Endovascular intervention in nephrology: results from a single centre

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ABSTRACT

Vascular access dysfunction is the main cause of morbidity and hospital admission in haemodialysis patients, entailing very high costs. Percutaneous endovascular intervention allows the salvaging of an important number of dysfunctional arteriovenous fistulae and grafts and as such is a key complement to surgical intervention.

In our study we reviewed the records of all the percutaneous endovascular procedures carried out over a 12-month period in our centre on patients with vascular access dysfunction. We characterised the patient population, type of vascular access, reasons for referral, the procedures performed and evaluated our results.

A total of 48 procedures were performed on 38 patients: 48 angiographies, 36 angioplasties, 10 percutaneous manual catheter-directed tromboaspiration, 7 percutaneous pharmacomechanical thrombolysis, 8 stents and 3 tunnelled cuffed catheters were placed. The mean age of patients was 65.4±14.4; 22 male, 16 female. The main reasons for referral were access thrombosis (39.5%), low flow rate (25%), increased venous pressure (16.7%) and limb oedema (12.5%). Grafts were present in 52% of cases and arteriovenous fistulae in 42%.

The territories most affected by stenosis were the venous anastomosis (23.8%) in patients with grafts, and the drainage vein (19%) in patients with arteriovenous fistulae. The initial success rate was 89%. Residual stenosis was detected in 14.3% of cases. Twenty nine percent of the vascular accesses had more than one intervention.

Primary patency rates were 60% for arteriovenous fistulae and 40% for grafts, at one year. The complication rate was 10.4%; and no case required surgical intervention.

Key-Words:
Angiography; haemodialysis; interventional nephrology; vascular access dysfunction.

INTRODUCTION

Vascular access (VA) dysfunction in haemodialysis (HD) patients results in inadequate treatment, increases morbidity and mortality and is a major cause of hospitalisation in these patients, with very high costs[1]. Hospital admissions due to VA-related problems account for up to 23% of total hospital admission in HD patients[1].

Many VA-related problems may be solved effectively and safely by percutaneous endovascular interventions, performed by trained nephrologists, reducing delays, hospital admissions, central venous

catheter use and costs[2,3]. These techniques have thus become a key complement to surgery in the treatment of VA dysfunction.

In our centre nephrologists have performed VA intervention since 2008, with an increasing number of procedures.

The aim of our paper is to review this experience and compare the results with those of the literature.

PATIENTS AND METHODS

We reviewed the records of all the endovascular procedures performed due to VA dysfunction in HD patients in our centre between June 2008 and June 2009.

For each patient we evaluated demographic data, end-stage renal disease (ESRD) aetiology, type of vascular access, vascular access age, referral centre, time between referral and procedure, reason for referral, location of stenosis, type of procedure performed, need to repeat the procedure, initial success, presence of residual stenosis and procedure complications.

Patient Preparation

All patients had ESRD and were undergoing haemodialysis.

Before the intervention, written, informed consent to the planned procedure was obtained. All interventions were performed as out-patient procedures, except when significant clinical complications occurred immediately or when the patients underwent their dialysis treatment late in the evening after declotting.

We carried out physical examination of the access and homolateral limb. Any sign of local infection was an absolute contraindication to performing the procedure.

All patients had recent complete blood count and coagulation study. During the procedure all patients underwent monitoring with continuous ECG recording, measurement of blood pressure and pulse oximetry. The procedures were performed under conscious sedation and local analgesia. All patients underwent dialysis session after the procedure.

Percutaneous Transluminal Angioplasty (PTA)

Clinical and angiographic assessments of the VA were performed and all cases underwent diagnostic angiography. This evaluation was made by direct puncture of the VA, with isosmolar contrast medium administration and visualisation of the vasculature. Any stenosis found was recorded. Stenosis considered to be clinically significant (superior to a 50% reduction of luminal diameter compared to adjacent nonstenosed segment, presence of collateral vessels and limb oedema in central venous stenosis) were submitted to angioplasty with adequate size high-pressure balloon, inflated to 25 ATM, for 30 to 60 seconds. When necessary, in lesions resistant to dilation this procedure was repeated, using a 1mm higher balloon.

Declotting

Thrombosed VA was either declotted by percutaneous manual catheter-directed tromboaspiration or, in some cases, declotted using percutaneous pharmacomechanical thrombolysis. Any underlying stenosis was unmasked and dilated in all cases.

The device used for percutaneous pharmacomechanical thrombolysis was a Pulse-Spray® catheter, and heparinised saline solution (5000U/100cc saline).

Endovascular Stents

Indications for stent placement were acute ruptures not controlled by prolonged balloon inflation, greater than 30% residual stenosis despite no residual wasting on the balloon, early recurring restenosis (< 3 months) and aneurysms. Only self-expandable stents were used: shape memory alloy recoverable technology (SMART) nitinol self-expanding stent.

Complications

Minor complications were defined as those with no clinical consequences, not needing additional intervention or in-patient hospitalisation, such as small haematomas, transient cutaneous rashes and prolonged nausea.

Initial Success

The results were assessed through evaluation of the percentage of residual stenosis present and through clinical evaluation of access flow after the procedure.

Success after thrombectomy with PTA was defined as presence of good flow after the procedure allowing performance of HD through canulation of the VA. The procedure was considered a failure in the absence of flow after intervention or when the flow was insufficient to allow a successful use of the VA.

We considered PTA successful when we had no residual or less than 30% residual stenosis with improvement or normalisation of the clinical abnormalities after dilation allowing the performance of HD through canulation of the VA.

Primary Patency

Primary patency was defined as the interval from the time of endovascular intervention until any reintervention on the access or end of follow up.

Follow-up data was collected from hospital clinical files that contain all vascular access-related procedures and from information gathered from the patients' haemodialysis centres.

Statistical analysis

Categorical variables are presented as distributions (frequencies and percentages). Descriptive statistics are expressed as means with standard deviation and correlations between two variables were determined using Pearson coefficient. Access patency rates were calculated using Kaplan-Meier survival analysis. *P* values less than 0.05 were considerer significant.

RESULTS

Patient Population

A total of 48 endovascular procedures were performed on 38 patients with VA dysfunction. Table I shows the patient population and the procedures performed.

Table I

Characteristics of the Population

Number of procedures	48
Number of patients	38
Age (years)	65.4 ± 14.4 (Range: 35 - 83)
Gender	Male 22 (58%)
Race	Caucasian (100%)
ESRD aetiology	n
Unknown	16 (42.2%)
Diabetic nephropathy	9 (23.7%)
Hypertensive nephrosclerosis	9 (23.7%)
Chronic pyelonephritis / Tubulointerstitial disease	3 (7.8%)
AL Amyloidosis	1 (2.6%)

Thirty-seven patients were referred by three haemodialysis centres and only one patient was being treated at our hospital. Table II characterises the vascular accesses observed.

Table II

Characteristics of the Vascular Accesses observed

Arteriovenous Fistulae			**20**
Left Radiocephalic			12 (60%)
Right Radiocephalic			1 (5%)
Left Brachiocephalic			5 (25%)
Right Brachiocephalic			2 (10%)
Arteriovenous Graft			**25**
Left Brachial-Axilary			**25 (100%)**
Tunnelled Cuffed Catheter			**3**
Left Femoral Vein			1 (33%)
Right Femoral Vein			1 (33%)
Right Internal Jugular Vein			1 (33%)
Vascular access age			
Age (months)	**n (%)**	**Grafts (n)**	**AVF (n)**
0-6	8 (17.8%)	6	2
6-12	12 (26.7%)	8	4
12-18	15 (33.3%)	9	6
18-24	7 (15,6%)	2	5
› 24	3 (6.6%)	0	3

Referral Motive

The reasons for referral are presented in Table III. The main reason for referral in patients with grafts was thrombosis (n=19), while in AVF patients the reasons for referral were more evenly distributed between poor flow rate (n=10), increased venous pressure (n=6) and limb oedema (n=4).

Most procedures were carried out in the first seven days after the referral (67% of patients), and 27% within the first 48 hours.

Table III

Referral Motive

Vascular access type	Referral motive	n
Global	**Thrombosis**	**19 (39.5%)**
(n=48)	Poor Flow Rate	12 (25%)
	Increased Venous Pressure	8 (16.7%)
	Limb Oedema	6 (12.5%)
	CVC Placement	3
Graft	**Thrombosis**	**19 (76%)**
(n=25)	Increased Venous Pressure	2
	Poor Flow Rate	2
	Limb Oedema	2
AVF	**Poor Flow Rate**	**10 (50%)**
(n=20)	Increased Venous Pressure	6 (30%)
	Limb Oedema	4 (20%)

Procedure Findings

A stenotic lesion was the underlying cause of dysfunction in most of the VA referred (n= 87.5%). In 12.5% of the procedures more then one stenosis was found. Table IV shows the distribution of the stenosis according to VA type.

Stents were placed in eight of the procedures (16.7%) The reasons for stent placement were early recurring restenosis (5) and elastic lesions (3) (Fig. 1).

Table IV

Distribution of the stenosis according to the VA type

Location of stenosis	Grafts (n)	Location of stenosis	AVF (n)
Venous Perianastomosis	11	Central Vein	5
Within Graft	6	Drainage Vein	5
Drainage Vein	4	Arterial Perianastomosis	4
Arterial Stenosis	1	Venous Anastomosis	4
Central Vein	1		
Total Stenosis: 42 (87.5%)			

Procedures Results

Total immediate success of angioplasty/thrombectomy was achieved in 89% of the cases. At the end of the intervention residual stenosis was detected in 14.3% of cases. Two patients underwent two interventions during the year, another two had three and one patient had five.

Primary patentcy rates were 60% for AVF and 40% for grafts at one year. Total immediate success was associated with a higher vascular access age (p=0.025) and venous perianastomosis (p=0.037).

Complications

Minor complications were identified in five cases (10.4%): four local haematomas and one contrast reaction. No case required surgical intervention and no patient died.

DISCUSSION

VA dysfunction is a major cause of morbidity and hospital admission in haemodialysis patients, with a significant impact on these patients' prognosis.

The major complication of both fistulas and grafts is the presence/development of stenosis. Stenosis can compromise the maturation of fistulas and is the major cause of dysfunction in both these types of VA, ultimately leading to VA thrombosis.

Interventional radiology is an excellent method for evaluating dysfunctional VA, allowing the simultaneous correction of the underlying problem. Percutaneous transluminal angioplasty (PTA) in dysfunctional arteriovenous fistulae (AVF) and grafts was first described in 1982, and has become in many centres the standard of care for VA stenosis treatment[4,5]. Although some results are controversial, several studies have shown the safety and efficacy of this technique[5,6], and some studies relate early stenosis detection and treatment to an increase

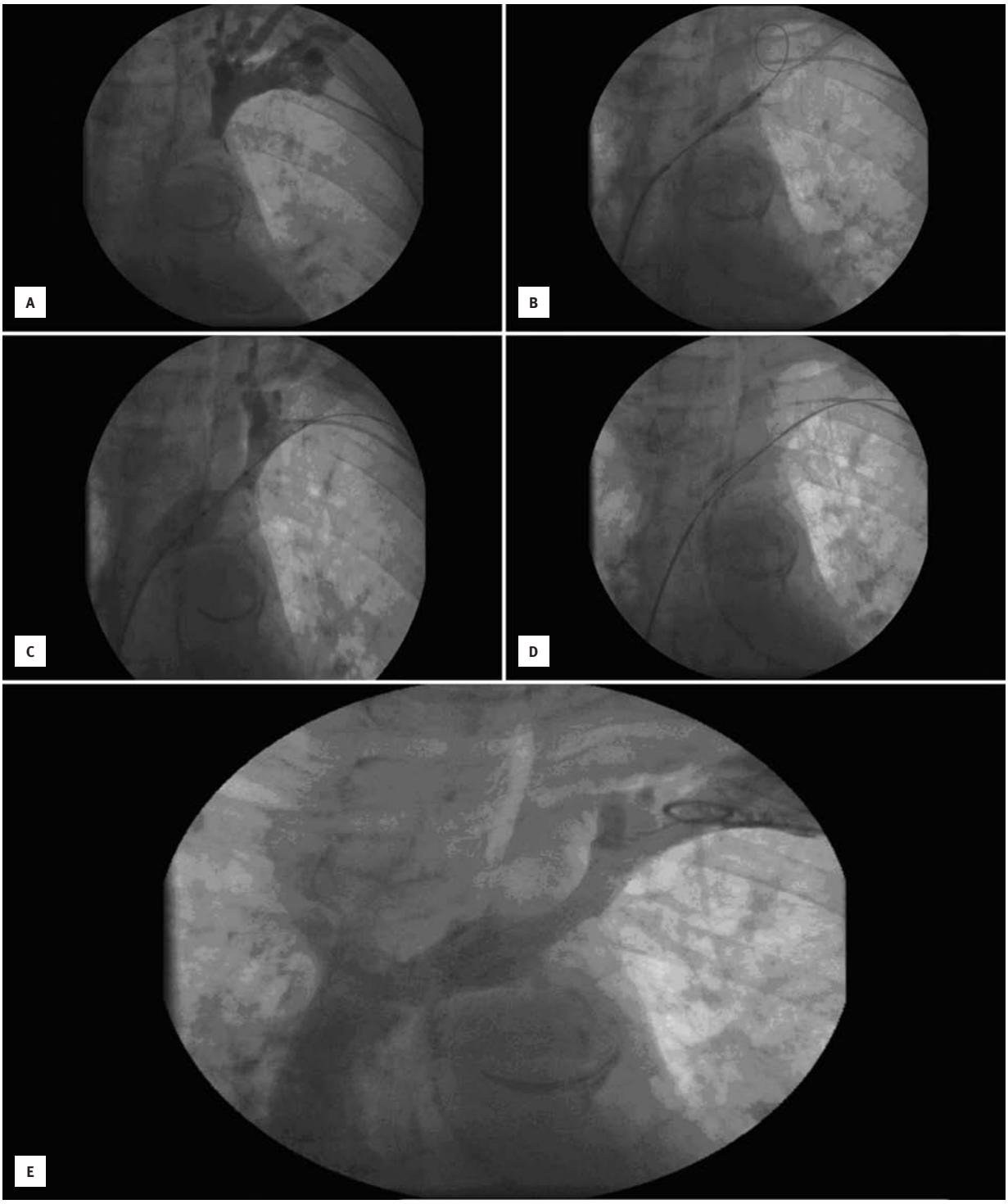

Figure 1

A) Left innominate vein stenosis in a patient with limb oedema. **B)** PTA with a high pressure (25 atm) 12mm balloon. **C)** Angiogram performed immediately alter PTA, with residual stenosis › 30%. **D)** SMART stent placement. **E)** An angiogram obtained after stent placement showing that venous flow has been re-established. After 18 months this fistula was still working perfectly, with no arm oedema.

in VA survival and a decrease in access-related morbidity[7,8].

Interventional radiology also allows immediate declotting of thrombosed VA. Pharmacomechanical thrombolysis is effective and safe, and is the treatment of choice in thrombosed PTFE grafts[9].

During the period of our study 48 cases of dysfunctional VA were referred to our centre.

Grafts thrombosis was the main reason for referral, representing 39.5% of the cases. In our series AVF were seldom referred due to other problems, namely poor flow rate and increased venous pressure.

Thrombosis is the most serious complication of permanent VA, and venous stenosis the main predisposing factor, accounting for 80-85% of thrombosis cases. In our study a stenotic lesion was the underlying cause of dysfunction in most of the VA referred (n= 87.5%); and the most frequent location of the lesions was similar to other studies' results[10].

PTA is a technique that is easy to perform and preserves vascular territory for new VA. It allows access to whole venous territory, including central vessels and usually permits the successful correction of stenosis associated with AVF and grafts[11]. Percutaneous angiography can be repeated, and 13.2% of our patients underwent more than one intervention. Our immediate success rate was 89%, similar to previous reports[2,12].

Recent data have emphasised that endovascular stents could be used in the treatment of central as well as peripheral stenotic lesions, and expanded the role of stents in the management of pseudoaneurysms associated with dialysis access. The use of endovascular stents, in this context, must take into account a fair comparison with the traditional (surgical) approaches regarding effectiveness as well as costs.

Our use of endovascular stents followed what is considered to be the standard indications in this context.

Primary patency rates found in the literature range from 29-40%[11,13,14] at one year for dysfunctional grafts, and range from 33-51% at one year for dysfunctional AVF.

In our centre primary patient rates were 60% for AVF and 40% for grafts at one year, with these results similar to those of other studies.

There were no serious complications and a relatively small number of minor procedure-related complications, similar to previous reports[6,15], with resolution of all situation during procedure without the need for vascular surgery.

Endovascular intervention is a key complement to surgical intervention. However endovascular therapy also avoids many surgeries and has the advantage of being less invasive, less painful, with less comorbidity rates and helps sparing venous territory.

Although our numbers are relatively small, our results are in line with the published literature and once again confirm that endovascular intervention is a safe and effective treatment for vascular access dysfunction.

Conflict of interest statement. None declared.

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